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but a company has been formed, and is now working the lead mines, and intend renewing their search for copper. In the neighbourhood of Guildford there is clay and sandstone of good quality, and our Company have procured some specimens of slate which promised well, but on digging deeper it was found in detached pieces of no value, embedded in clay: near this slate there is a stone similar in appearance and texture to the "Turkey stone;" it is a combination of silica, alumina, and iron. Anthracite coals have been obtained near Perth, but of very inferior quality. I do not think there is anything more of interest either to the geologist or mineralogist. The great scarcity of water, the parching heat of the dry season, and the uncertainty of the wet one, will always render this country liable to great fluctuations in the amount of agricultural products, and more or less dependent on other countries for food, and there is very great doubt in the opinion of some of the first settlers (now 23 years) that this colony can ever support even a moderate population. At present there is not six months' supply raised, and the large tracts of barren wastes between the few available patches give little encouragement to any agricultural undertaking. There are hundreds of miles where there is nothing but sand, bush, and forest. The trees of the latter are well adapted for both building and hydraulic purposes, the timber being impervious to the white ant, and retaining its properties under water; but the procuring of it is so expensive as to make any building much dearer than it would be in London.

The Convict Establishment and our Company have given an impetus to trade, but time will show whether it be judicious to select a spot for this purpose which offers so few inducements to agricultural pursuits.

*To Captain Scott, R.E.*

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X.—*On the Navigation of the Murray.* By Captain THOMAS CADELL.

*Read, Feb. 27, 1854.*

To the PRESIDENT of the Royal Geographical Society.

Adelaide, Nov. 15, 1853.

SIR,—I do myself the honour to address you regarding the first steam voyage ever performed on the Murray River, from the sea mouth to within 50 miles of its junction with the Campaspy; also about 60 miles up one of its tributaries, the Wakúl, and a few miles up the River Darling.

Having entered into a contract with the South Australian Government to place a steamer of a given horse-power on the

River Murray, and with the view of exploring the stream before taking the steamer up, in September, 1852, I made the first descent of the main branch of the river (Captain Sturt having descended the Murrumbidge) \* in a small canvas boat, when I fully satisfied myself of its practicability of being navigated by steam power.

Since the time alluded to I have been principally employed in the construction of my vessels, in examining the sea mouth, and various portions of the Murrumbidge and Home, as well as other tributaries of the Murray. I here subjoin an extract taken from the Blue Book :—"The great surf that is constantly breaking on the Encounter Bay coast, at the spot where the River Murray discharges itself into the sea, renders the entrance into the river from the sea most dangerous, and indeed impracticable: hence, any steamer intended for the inland navigation must either be built, or put together, on the shores of the river or lake."

The sea mouth I do not consider in the same unfavourable light after many and repeated observations from the year 1848, when I first examined it, until the 15th of August last, when I took the steamer in. I have no hesitation in pronouncing it a navigable channel during quiet weather for properly constructed steamers, although great care would be constantly required, as its channel shifts every gale of wind, its invariable tendency being to work to the eastward.

Before the 'Lady Augusta's' arrival from Sydney, I established a party under an officer on Barker's Knoll (where Captain Barker of H.M.'s 39th was killed when taking angles), for the purpose of watching the breakers on the bar, and making "tidal observations," also to signalize to Port Elliot when the entrance might be attempted.

The result of these observations induces the belief that there is no *regular rise and fall*. For some successive days the tide of ebb would be found suddenly to cease from 10 to 11 A.M., no *slack water* would intervene, and the flood would come in, say for four hours. But for days, and I may say weeks together, the river steadily and without intermission disembogues itself into the sea.

The ocean all round Encounter Bay recedes every evening about sunset, advantage of which is taken by the settlers to cross the *Hindmarsh* and *Iuman*, at their estuaries.

My boats have frequently crossed the bar at the sea mouth, and only one capsized took place: fortunately all of us were saved.

I may here mention a singular fact which came within my ob-

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\* Capt. Sturt not only descended the Murrumbidge, but also the Murray to the coast. See Journal R. G. S., vol. ii. p. 99, &c.; see also vol. viii. p. lvi.—Ed.

servation when watching the breakers at the sea mouth, and which shows that the instinct of the whale leads her to perform *exactly the same operation* which is found *so effective* with iron ships after a long voyage. It is this: that the whale, feeling herself covered and uncomfortable from *barnacles* on her skin, strikes in for the mouth of the river and there plays and gambols for hours, just outside or amongst the breakers. Having rolled the barnacles off in the fresh water, she again takes to sea. It is the knowledge that the fresh water kills the barnacles that brings her in: whenever it was practicable, my whalers, as well as those of the opposition fishery, were glad to take advantage of this peculiarity of the fish.

Lake Alexandrina is a large and generally shallow expanse of water, but fit at any season of the year to allow a vessel drawing 5 feet to pass, in still weather and in the proper channel. It will now not only be used in connection with the Murray River, but also to carry on its bosom the wool of the Tattiarra District, at present conveyed to Adelaide by crossing the *Hundred Mile Desert*, and a large portion of the wool now shipped at Guichen Bay will also be lake borne.

That part of the lake extending 90 miles in a S.E. direction from the sea mouth, called the Curong, is capable of being navigated at certain seasons by steamers of shallow draught.

Large tracts of agricultural country bordering on the lake will be speedily occupied and tilled.

The Murray at its entrance to the lake and in the neighbourhood of Wellington may be about 200 yards wide, with soundings frequently as deep as 10 fathoms.

From 100 to 150 yards may be taken as an average breadth of the river up to its junction with the Darling, which river seems to have very little influence either in contracting or expanding the main stream, it being fed principally by the back waters of the Murray.

Neither does the Murrumbidgee visibly increase the volume of waters of the Murray, although it is of great length; and its stream at Gundagai, in keeping with the general character of Australian rivers, although 300 miles farther in the interior, there presents a more open and freer channel than at its junction.

The Wakul, although only (as it is termed here) an "ana" branch, materially affects the basin of the Murray, and any stranger ascending would certainly steer up the Wakul, leaving the comparatively insignificant Murray on the right.

From the junction of the Wakul up to the neighbourhood of Swanhill, the Murray becomes contracted, tortuous, and much impeded with fallen timber, "*snags*" and "*sawyers*" presenting many serious impediments to navigation, and the set of the current

is so strong, that the rudder becomes comparatively powerless, and the vessels constantly take the ground, or rather the banks, which latter are very steep.

In the neighbourhood of Swanhill, where the Murray's course lies through reed-beds, no obstacles interrupt the navigation, although the river is still very tortuous.

Above Swanhill it is divided, by an island of considerable extent, into two branches, the smallest and most easterly being called the *Mabut*, which is unnavigable. On the junction of the two branches the river again expands, and at Aldbury presents a good navigable stream.

The above remarks are only to be considered applicable during the floods, which are most capricious and sometimes sudden in their rise, although the "*flood-wave*" travels down the river at a very slow rate. For instance, on my passage up in the '*Lady Augusta*,' I met the *flood-wave* below the Darling, passed it before I reached Swanhill, but did not reach the second *flood-wave*, which, only a few miles distant from me, was caused by the *Cam-paspy's* rising.

On my downward voyage I found that the *flood-wave* had preceded me (and the river fallen) until I came up with it below *Chowilla*, and I did not run past it until near *Wall*, about 60 miles from Wellington.

I hope, when I become better acquainted with the velocity of these "*flood-waves*," to be able to give your learned Society some interesting information, and the establishment of Nilometers at given points on the river would bring out some curious facts.

The last and "snow-flood" generally comes down this month, caused by the melting of the "snows" on the Australian Alps.

The vertical annual rise of the Murray may be estimated from 16 to 20 ft., but the Murrumbidgi often doubles and frequently trebles that "rise." When I visited Gundagai in November, 1852, about four months after that township was swept away, I saw *horses* and *bullocks* suspended by the legs by limbs of the gum trees, full 30 ft. above the bank of the river and 40 above the stream.

The Darling is the most uncertain of all the tributaries of the Murray, and its rise is at times very sudden: this year it has only been navigable for about 30 miles.

If the Murray River is found navigable as high as the Darling for six months, and as far as Swanhill for eight months, it is as much as I expect.

The Colonial Governments will probably unite in the expenditure of a certain sum for clearing the river of fallen trees, "snags," &c. &c., the accumulation of ages, which will very much facilitate and increase the safety of navigation; many overhanging branches

of trees will also require to be cut off, as they constantly endanger the funnels of the steamers.

The banks of the river are plentifully covered with fine timber; indeed for hundreds of miles on a stretch the river appears like an "avenue," with rows of trees on both sides; and what is remarkable, the same "genus" of trees never appear facing each other. If gum trees are on one bank, the opposite grows "*she-oak*," "*peppermint*," and "*box*." These trees, seldom interspersed with the gum, suddenly and without any apparent cause shift over to opposite sides of the river. Thus, my shipbuilding-yard on the Wakúl is surrounded on one side by crooked box trees, from which the frames or ribs are taken, whilst we are forced to cross to the opposite bank to cut planking from the straight "flooded gum" trees.

*Pines* crown all the eminences on both banks of the river, as far as I have ascended. Unfortunately this pine is found so brittle, knotty, and liable to decay, that we only use it for "fuel;" the bark contains much "resin," but although quick and fierce in burning it does not last long, and we find good *dry gum* to be our best burning wood.

Amongst the pine clumps is frequently found a stunted *bastard sandalwood*, unfit for commercial purposes, and used by us for boats' timbers and knees.

*Magal* abounds betwixt the Darling and Murrumbidgee, in the back country, but it never attains any size greater than a bush.

The high "ridges" or "cliffs" which the Murray cuts through, sometimes obliquely, sometimes at right angles, terminate on the N.S.W. bank about 8 miles below the junction of the Murrumbidgee, and on the Victoria side at Willilú, near Euston. They are composed principally of a *red* and *white* clay, with layers of half calcined white sandstone, friable to the touch and rapidly dissolving in water.

The formation of the cliffs in the neighbourhood of Morrundí, Captain Sturt has described in his first work.

From the point alluded to on the N.S.W. side, the Murray, as high as the Ovens River, flows through a vast level country, with occasional slight undulations dignified by, but undeserving, the name of hills.

*Winds*.—Like other large rivers, the Murray appears to draw a current of air up its stream. It seems that the prevalent wind in the country through which it flows is S.W., although, before the "great flood" of 1852 swept away the old camps or *gunyas* of the natives, I observed that they generally fronted or faced to the N.W., which would tend to show that the prevailing wind was from S.E.

At sunset, should the wind have been up, it generally dies away, and is succeeded by a faint air from the Northward or down stream.

By the same mail which takes this hurried communication (as I leave to-morrow on my second voyage) I send newspapers and a pamphlet containing articles on the river, which I trust may be found of interest.

Since my return, the Legislative Council of this colony have awarded to me a "*gold medal*" for opening up and showing the capabilities of the river, and have also voted me 4000*l.* as a bonus, to place two steamers on the upper rivers. Next flood I look forward to having five steamers on the river, and a boat to go outside. These steamers, with a sufficient number of barges, will be amply sufficient for all goods and passenger traffic. Indeed, the Governments of all the colonies, as well as the settlers on the river, have given me every inducement to prosecute the enterprise.

When the new steamers are on the river I look forward to reaching the *Mitta Mitta* by the *Home*; *Seymour*, about 40 miles from Melbourne, by the *Goldburn*, between *Yass* and *Gundagai* on the *Murrumbidgee*, and *Wangaratta* on the *Ovens*: as to the Darling, I am afraid to hazard an opinion.

I did myself the honour of addressing you by letter, dated "Lady Augusta, 5th Oct., 1853," proffering my services to leave any stores on the Murray or Darling, which might possibly be required for the "Exploring Expedition" which, under your auspices, is to be started for the interior. I can now only repeat what I said then.

My time, since my return to Adelaide from the Murray, has necessarily been much occupied in carrying out affairs connected with a navigation of such recognised importance, which I trust will serve as an excuse for the hurried manner in which these remarks have been thrown together; and, looking forward some day to be of substantial use to your learned body,

I have the honour to be, Sir,

Your obedient servant,

THOMAS CADELL.

XI.—*Notes on the Passage of Hannibal across the Alps; and on the Valley of Beaufort, in Upper Savoy.* By Professor PAUL CHAIX, of Geneva, Corresp. F.R.G.S.

*Read, May 24, 1855.*

THAT "*vexata quæstio*," the passage of Hannibal, has recently undergone fresh investigation in a work by Mr. Schaub, of Geneva. The author begins with a brief summary of opinions of certain previous writers. Many of the views that have been advocated